Transportation Applications

Transportation industries are, by their very nature, geographically distributed, with roads and rails linking widely separated cities, and air and sea routes spanning the globe. The primary strength of satellite imagery, frequent and consistent coverage over the entire globe, supports the planning and management needs of the transportation industries.

For land-based applications, satellite imagery from NASA's ESE can provide a major addition to Geographical Information System (GIS) databases currently in use for transportation planning and construction. Integrating recent satellite data with GIS datasets such as urban zones and utilities layouts can provide a powerful package for reducing costs and leveraging new business opportunities. Satellite data will also be valuable for monitoring shipping and improving forecasts of marine conditions.

All transportation industries are susceptible to global climate and climate change. Annual losses to the transportation industry due to severe weather (e.g., road and rail damage in storms, landslide impacts) amount to at least $1.5 billion each year. An improved understanding of global climate and climate change would help all sectors of the transportation industry plan for future operations. In line with the ESE program goals to better understand the complex mechanisms responsible for the global climate and quantify the effects of climate change, numerical models are being developed that offer improved long-term prediction of El Nino/ENSO and hurricane frequency. By collecting simultaneous observations of atmospheric, oceanic, and land parameters over the globe, the ESE program will substantially improve future model results.

Current and potential uses of satellite remote sensing data for transportation are listed below. In the Transportation Applications Matrix, the rows correspond to specific applications, and the columns correspond to individual ESE instruments. The potential use of data from a given ESE instrument to a specific transportation application is denoted by a check mark in the matrix.

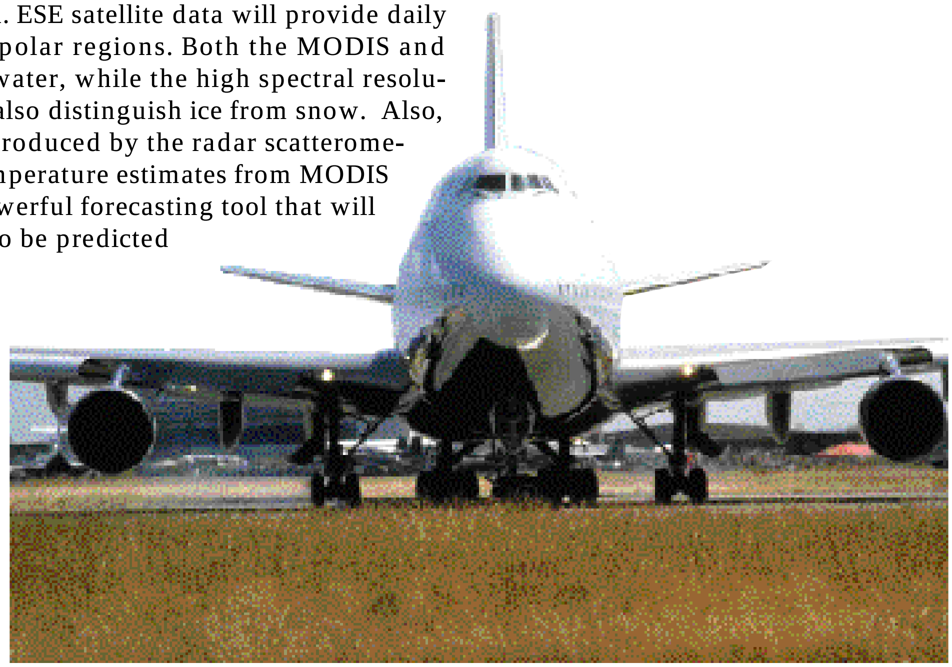
Transportation Applications Matrix

Application	ESE Instrument											
	MODIS	ASTER	Landsat 7	MISR	Sea Winds	EOS Models	LIS	AMSR/ TMI	SRTM	AMSR	AIRS/ AMSU/ MHS	DFA/ MR
A. Marine Scenarios												
1 Monitoring Marine Ice	✓	✓	✓	✓	✓					✓		✓
2 Improving Marine Forecasts	✓				✓	✓				✓		
3 Managing Inland Waterway Logistics	✓	✓	✓			✓		✓				
B. Land and Aviation Scenarios												
4 Mapping Road Networks		✓	✓									
5 Analyzing Urban Growth/Market		✓	✓									
6 Analyzing Cost-Surface Construction	✓	✓	✓	✓					✓			
7 Improving Aviation Forecasting	✓				✓	✓				✓	✓	

A. Marine Scenarios

1 Monitoring Marine Ice

In the northern oceans, drifting sea ice can present a major hazard to shipping and can impede efficient ship navigation. ESE satellite data will provide daily coverage of sea ice distribution in the polar regions. Both the MODIS and MISR sensors can distinguish ice from water, while the high spectral resolution of MODIS will allow that sensor to also distinguish ice from snow. Also, the global maps of oceanic wind fields produced by the radar scatterometer SeaWinds, combined with surface temperature estimates from MODIS thermal infrared data, will provide a powerful forecasting tool that will allow ice flow distribution and motion to be predicted days in advance.



2 Improving Marine Forecasts

Improved weather and storm prediction provides direct benefits to shipping, allowing improved navigation and logistical planning. Shipping firms can better plan routes and alter departure dates to avoid storm systems, thus saving money and improving safety. ESE instruments can help provide improved weather prediction both directly by tracking of wind fields via SeaWinds, mapping of cloud thickness and type with MODIS, and indirectly by improved performance of numerical weather models using ESE data.

3 Managing Inland Waterway Logistics

Barge traffic along major rivers, lakes, and coastal waterways, is particularly sensitive to regional climate. During the 1993 Mississippi flood, for example, 1612 miles of waterway network were closed, stranding 1075 barges in the upper Mississippi, ultimately causing losses approaching $1 million per day for the barge industry. On the other hand, drought can reduce water levels to the point where rivers become impassable, also causing stranded cargo and lost revenue. More accurate prediction of river stage would allow shipping companies to plan for these economic impacts in advance and move barges to optimal locations where they could be kept in service.

Hydrologic modeling can aid in this effort, but these models depend on precipitation, land cover, and soil moisture data as input. ESE observations can provide input daily. Observations from MODIS, AMSR, and TMI entered into atmospheric models will allow more accurate prediction of regional precipitation. In addition, the AMSR and TMI passive microwave instruments will measure soil moisture directly, frequent observations of which can aid in predicting runoff, subsurface flow, and flooding.

Transportation Applications

In addition, large floods can damage waterways, particularly through transport and buildup of sediment in downstream reaches, resulting in reduced draft, reduced traffic, and costly dredging of channels. The reflectance of suspended sediment in water is characteristic in the visible and near-infrared spectral regions; MODIS, ASTER, and Landsat 7 will be able to track sediment plumes during major floods. Using data from these instruments, engineers will be able to target problem areas on waterways and better allocate resources for mitigating the problem of sediment buildup.

B. Land and Aviation Scenarios

The primary use for remote sensing in land transportation will be in developing countries, where demographic data are sparse and transportation networks evolve rapidly in response to increased urbanization. Nevertheless, the global nature of today's economy means that American companies are often involved in developing countries, as contractors, investors, and infrastructure providers. Providing these companies with accurate information for remote areas will be a major benefit of global remote sensing.

4 Mapping Road Networks

For companies doing business in developing nations, proper mapping of transportation networks is essential. High-resolution satellite images from the ASTER and Landsat 7 instruments will provide useful data for frequent mapping of existing networks.

5 Analyzing Urban Growth/Market

Because the market for transportation services depends on population density, planning for new infrastructure development—roads, rail, airports, or new airline services—it is necessary to know which regions are growing in population. Mapping urban growth is a proven application of satellite remote sensing. High resolution visible imagery from ASTER and Landsat 7 can distinguish roads, buildings, farms, and airports anywhere on Earth, every 10-15 days. When combined with existing Landsat data from the past 25 years, the ESE program will provide a 40-year record of demographic growth around the globe.

Urban hot spots are being studied by Global Hydrology and Climate Center researchers at NASA's Marshall Space Flight Center in Huntsville, AL. This image of Atlanta, GA was taken by a Lear Jet equipped with thermal imaging equipment which flew over the metropolitan area during May 1997. City planners are using images such as these to plan urban growth while maintaining air quality and the environment.

6 Analyzing Cost-Surface Construction

Cost-surface construction involves calculating the cost-per-mile of building roads, rail lines, pipelines, or utilities based on local topography, land cover, and existing infrastructure. To assist in the planning, local governments can use ASTER data to create precise digital topography. In addition, the ESE visible / near-infrared sensors are designed specifically to map vegetation and land cover type. By combining land cover data with digital elevation data, organizations will be able to more effectively identify sites for specific facilities or determine more cost-effective routing of features such as pipelines and transportation networks.

7 Improving Aviation Forecasting

Weather exerts a considerable impact on airport operations and aviation services. Volcanic plumes, for instance, can present a distinct hazard to commercial air traffic, damaging windows and clogging air intakes. ESE instruments, such as MODIS, will provide daily global images of volcanic plumes that can be used by airlines to determine alternate routes.